

COMMENT ON "HYBRIDIZED TETRAQUARKS"

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Abstract

In this comment, I illustrate that the formula $\Gamma = A\sqrt{\delta}$ suggested in arXiv:1603.07667 comes from a kinematical factor, and has no relation to the existence or non-existence of the $X(5568)$.

In the two-body strong decays $A \rightarrow BC$, the partial decay width can be written as

$$\Gamma = \frac{1}{2j_A + 1} \frac{p}{8\pi m_A^2} |T|^2, \quad (1)$$

where

$$p = \frac{\sqrt{[m_A^2 - (m_B + m_C)^2][m_A^2 - (m_B - m_C)^2]}}{2m_A}, \quad (2)$$

is the three momentum of the final mesons in the center of mass of the initial meson A , the j_A is the spin of the initial meson A , the T is the scattering amplitude. If there exists a relative angular momentum L between the final mesons B and C , then

$$\Gamma \sim p^{2L+1}. \quad (3)$$

Now we set $L = 0$ for simplicity.

In the case $m_B \approx m_C$,

$$\begin{aligned} p &\approx \frac{\sqrt{m_A + (m_B + m_C)} \sqrt{m_A - (m_B + m_C)}}{2} = \frac{\sqrt{2(m_B + m_C) + \delta}}{2} \sqrt{\delta} \\ &\approx \frac{\sqrt{2(m_B + m_C)}}{2} \sqrt{\delta}, \end{aligned} \quad (4)$$

where $\delta = m_A - (m_B + m_C) \ll m_B + m_C$. The three momentum p in the decays

$$\begin{aligned} X(3872) &\rightarrow \bar{D}^0 D^{*0}, \\ Z_c^+(3900) &\rightarrow \bar{D}^0 D^{*+}, \\ Z_c^+(4025) &\rightarrow \bar{D}^{*0} D^{*+}, \\ Z_b^+(10610) &\rightarrow \bar{B}^0 B^{*+}, \\ Z_b^+(10650) &\rightarrow \bar{B}^{*0} B^{*+}, \end{aligned} \quad (5)$$

can be well approximated by Eq.(4) [1]. The partial decay widths can be well fitted into the following form,

$$\Gamma = A\sqrt{\delta}, \quad (6)$$

where A is a fitted parameter [2]. The formula in Eq.(6) comes from a kinematical factor, the hybridization mechanism proposed in Ref.[2] is unnecessary. In fact, those partial decay widths have not been measured yet, even the total widths have not been precisely measured, some decays have not been observed yet [1]. We can only say that the partial decay widths are of the form $\Gamma = A\sqrt{\delta}$, as the input parameters are not robust.

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In the case $m_B \gg m_C$,

$$p = \frac{\sqrt{m_A + (m_B + m_C)}\sqrt{m_A + (m_B - m_C)}\sqrt{m_A - (m_B + m_C)}\sqrt{m_A - (m_B - m_C)}}{2m_A} \approx \frac{m_A + m_B}{2m_A}\sqrt{\delta}\sqrt{\delta + 2m_C}, \quad (7)$$

where $\delta = m_A - (m_B + m_C) \ll m_B + m_C$. The three momentum p in the decays

$$Y(4140) \rightarrow J/\psi \phi, \quad (8)$$

$$Z(4430) \rightarrow \eta'_c \rho, \quad (9)$$

$$X(5560) \rightarrow B_s \pi, \quad (9)$$

can be well approximated by Eq.(7), not by Eq.(4). The decay $Z(4430) \rightarrow \eta'_c \rho$ has not been observed yet, and the partial decay width of the process $Y(4140) \rightarrow J/\psi \phi$ has not been measured [1]. The partial decay widths can be written into the form,

$$\Gamma = A\sqrt{\delta}\sqrt{\delta + A'}, \quad (10)$$

not the form in Eq.(6), where the A and A' are fitted parameters. In the case $\delta \ll A'$, Eq.(10) is reduced to Eq.(6). Here I assume the spin-parity J^P of the $Y(4140)$ is 0^+ or 2^+ . Again the formula in Eq.(10) comes from a kinematical factor, the hybridization mechanism proposed in Ref.[2] is unnecessary. In Ref.[2], the widths of the $Y(4140)$, $Z(4430)$ and $X(5568)$ cannot be well approximated by Eq.(6).

In the chiral limit $m_C = m_\pi \rightarrow 0$,

$$p \approx \frac{m_A + m_B}{2m_A} \delta. \quad (11)$$

The three momentum p in the decays

$$Z_c(3900) \rightarrow J/\psi \pi, \quad (12)$$

$$Z(4430) \rightarrow \psi' \pi, \quad (12)$$

$$X(5560) \rightarrow B_s \pi, \quad (13)$$

can be approximated by Eq.(11). The partial decay widths can be written into the following form,

$$\Gamma = A\delta, \quad (14)$$

not the form in Eq.(6), where the A is fitted parameter. Again the formula in Eq.(14) comes from a kinematical factor.

In summary, the δ dependence of the partial decay widths comes from the kinematical factors, the hybridization mechanism proposed in Ref.[2] is unnecessary, and has no relation to the existence or non-existence of the $X(5568)$ [3].

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References

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